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Mine Workers, Heat Related Illnesses, and the Role of the Occupational Health Nurse

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Student Spotlight

Mine Workers, Heat Related Illnesses, and the Role of the Occupational Health Nurse

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Across the United States, workers in many occupations face weather and related extreme conditions on a daily basis. Hot weather and manual labor increase a person's core body temperature. This heat gain comes from a combination of environmental and self-generated (or internal) heat. Environmental heat is both weather related and man-made, and internal heat is produced from metabolic processes (Xiang, Bi, Pisaniello, & Hansen, 2014). But, it's just not the heat that causes problems; it's the humidity, too. Each year thousands of workers suffer heat related illnesses as a result of becoming overheated. Between June, 2013 and July, 2014, heat related illnesses were responsible for more than 20 occupational worker deaths in the U. S. (Occupational Safety and Health Administration [OSHA], 2014). Miners are at an increased risk for heat related illnesses. Workers in underground mines are exposed to ambient temperatures and relative humidity while performing their job duties decked out in safety equipment. Surface mine workers endure outdoor environmental temperatures under the same safety precautions. The aim of this paper is to outline the various heat related illnesses suffered by coal miners, summarize the findings from several published studies, offer suggestions to Occupational Health Nurses for reducing heat exposure in miners, and propose future directions for research.

Background

Worldwide, approximately 24,000 coal mines exist (World Coal Association, n.d.). In the United States, there are 1,061 coal mines with 877 coal mines in the Appalachian region of the United States (U.S. Energy Information Administration [EIA], 2015b). The Appalachian region stretches from Southern New York to Northern Alabama and into Eastern Mississippi. Central Appalachia (Kentucky, Tennessee, West Virginia, and Virginia) is home to 525 coal mines: 248 underground mines and 277 surface mines (EIA, 2015b). In 2013, 18,853 people were employed in underground Central Appalachian mines, and 9,089 people were employed in Central Appalachian surface mines (EIA, 2015a). Coal mining is considered one of the most dangerous jobs in the world, and each day miners are exposed to a variety of hazards, both fatal and non-fatal.

In 2014, there were 16 fatalities in coal mines across the United States (Mine Safety and Health Administration [MSHA], n.d.a). Ten of the fatalities occurred in the Appalachian region, and nine from the Appalachian region were in Central Appalachia (MSHA, 2015). Most fatalities were related to physical hazards such as falls, explosions, and equipment accidents (Donoghue, 2004a). Heat, also considered a physical hazard, has contributed to approximately 150 miners suffering from some type of non-fatal heat related illness (MSHA, n.d.c) such as heat stroke, heat exhaustion, heat cramps, and heat rash (Centers for Disease Control and Prevention [CDC], 2014; Lutz, Reed, Turner, & Littau, 2014; OSHA, n.d.). Heat related illnesses are also the cause of injuries resulting from falls and equipment operation accidents (Washington State Department of Labor & Industries, n.d.) as workers develop symptoms such as sweaty palms, confusion, seizures, dizziness, fatigue, hallucinations, and muscle cramps (CDC, 2014).

Types of Heat Related Illnesses

Heat Stroke

Heat stroke is the most serious heat related illness and can quickly result in death if not treated (Lutz et al., 2014; OSHA, n.d.). It is associated with central nervous system dysfunction and is characterized by a high core body temperature (above 104°F), confusion, ataxia, nausea and vomiting, tachycardia, tachypnea, and headache (Donoghue, 2004b; Keim, Guisto, & Sullivan, 2002). Complications include: hemorrhage, acute renal failure, rhabdomyolysis, and liver failure (Donoghue, 2004b; Glazer, 2005).

Heat Exhaustion

Heat exhaustion is the most common heat related illness and is the result of dehydration. Signs and symptoms include: a core body temperature between 98.6°F and 104°F, dizziness, weakness, headache, and syncope (Donoghue, 2004b; Glazer, 2005). Complications are less severe than heatstroke and include: hypotension, oliguria, tachycardia, and confusion (Glazer, 2005).

Heat Cramps

Heat cramps are often the first sign of a heat related illness and are characterized by involuntary contractions of the skeletal muscles. Heat cramps are painful, can occur in the legs or abdomen, and usually last a few minutes (Donoghue, 2004b; Keim et al., 2002).

Heat Rash

A Heat rash is the least serious heat related illness. It is the result of clogged pores from exposure to high heat and humidity. It is characterized by tiny red bumps, or blister like areas on the surface of the skin from sweat trapped under the skin (Keim et al., 2002).

The Heat Effect on Miners

Heat is a common problem in the mining industry. Surface miners are frequently exposed to high wet-bulb globe temperatures, especially during the summer months when it can exceed 30°C (Hunt, Parker, & Stewart, 2013). "The Wet Bulb Globe Temperature (WBGT) is a measure of the heat stress in direct sunlight, which takes into account: temperature, humidity, wind speed, sun angle and cloud cover (solar radiation). This differs from the heat index, which takes into consideration temperature and humidity and is calculated for shady areas" (National Weather Service, 2015, para. 1). Underground miners are vulnerable to heat accumulation as the result of high heat flow from the earth, heat from virgin rock, and additional safety equipment such as self-contained self-rescue apparatuses (MSHA, n.d.b; Lutz et al., 2014; Xiang et al., 2014). Most heat related illnesses occur during daylight hours when the temperatures are higher (Xiang et al., 2014). In a study of three mine sites across northern Australia, 87% of surface miners (n=91) and 79% of underground workers (n=56) reported experiencing at least one symptom of a heat related illness during their shift, and 81-82% reported symptoms more than once during their shift. Seventy-one percent of surface miners were dehydrated prior to starting their shift with similar numbers in underground miners (Hunt, Parker, & Stewart, 2013). In a similar study of a mine blast crew in the tropics (n=15), 73% of workers complained of at least one symptom of a heat related illness during their shift, and 88% were dehydrated prior to the beginning of their shift (Hunt, Parker, & Stewart, 2014). In each study, the dehydration status did not improve during the shift (Hunt et al., 2013; Hunt et al., 2014). In the U.S., between January, 1983 and December, 2001, 538 mine workers reported at least one symptom of a heat related illness during their shift, and 79.4% of the incidents occurred during the summer months (Donoghue, 2004b).

The Occupational Health Nurse's Role in Combating Heat Related Illnesses

There are several factors that put miners at an increased risk for heat related illnesses: hypohydration, increased body mass index (BMI), poor aerobic fitness, and lack of heat acclimation (Brake, 2001; Donoghue, Sinclair, & Bates, 2000). Occupational health nurses can help decrease the risk of symptoms related to heat illnesses by providing education and developing programs and policies to encourage hydration both prior to and after worker shifts as a high number report to duty hypohydrated and during shifts as they continue to deplete their fluids (Brake, 2001;

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Kalkowsky & Kampmann, 2006). Fitness programs serve a dual purpose; they can help decrease BMI and increase aerobic fitness as higher BMI's have been positively correlated with an increase in heat illnesses (Donoghue & Bates, 2000; Lutz et al., 2014). The development of acclimation programs and self-pacing programs can reduce the incidences of symptoms of heat related illnesses by promoting shorter work-rest cycles, encouraging workers to rest more often, working at slower rates in higher temperatures, and reporting symptoms earlier (Donoghue et al., 2000; Hunt et al., 2014; Xiang et al., 2014).

Conclusion

Most studies on heat related illnesses in miners have occurred outside of the U. S. Those studies have shown that a significant number of mine workers reported at least one symptom of a heat related illness during their assigned shift. Dehydration was noted to be the leading cause of heat exhaustion especially during the summer months. Education and the development of programs and policies by occupational health nurses can help combat the incidences of heat related illness symptoms. As limited data exist on heat related illnesses in miners in the U.S., more research is needed to determine the potential effects of heat exposure on heat related illnesses in mine workers in the Appalachian region of the U. S.

References

Brake, R. (2001). Fluid consumption, sweat rates and hydration status of thermally-stressed underground miners and the implications for heat loss and shortened shifts. *Queensland Mining Industry Occupational Health and Safety Conference.* Townsville, Australia. Retrieved from http://www.pointhealth.com.au/pdf/Fluid%20consumption,%20sweat%20rates%20and%20hydration%20status%20of%20therm.pdf

Centers for Disease Control and Prevention. (2014). *Heat stress.* Retrieved from http://www.cdc.gov/niosh/topics/heatstress/

Donoghue, A. (2004). Occupational health hazards in mining: An overview. *Occupational Medicine*, 54, 283-289. doi:10.1093/occmed/kqh072

Donoghue, A. M. (2004b). Heat illness in the U.S. mining industry. *American Journal of Industrial Medicine*, 45, 351-356. doi:10.1002/ajim.10345

Donoghue, A. M., & Bates, G. P. (2000). The risk of heat exhaustion at a deep underground metalliferous mine in relation to surface temperatures. *Occupational Medicine*, 50(4), 334-336. doi:10.1093/occmed/50.4.259

Donoghue, A. M., Sinclair, M. J., & Bates, G. P. (2000). Heat exhaustion in a deep underground metalliferous mine. *Occupational and Environmental Medicine*, 57(3), 165-174. doi:10.1136\oem.57.3.165

Glazer, J. L. (2005). Management of heatstroke and heat exhaustion. *American Family Physician*, 71(11), 2133-2140. Retrieved from http://www.aafp.org/afp/2005/0601/p2133.pdf

Hunt, A. P., Parker, A. W., & Stewart, I. B. (2013). Symptoms of heat illness in surface mine workers. *International Archives of Occupational and Environmental Health*, 86, 519-527. doi:10.1007/s00420-012-0786-0

Hunt, A. P., Parker, A. W., & Stewart, I. B. (2014). Heat strain and hydration status of surface mine blast crew workers. *Journal of Occupational and Environmental Medicine*, 56(4), 409-414. doi:10.1097/JOM.0000000000000114

Kalkowsky, B., & Kampmann, B. (2006). Physiological strain of miners at hot working places in German coal mines. *Industrial Health*, 44, 465-473. doi:10.2486/indhealth.44.465

Keim, S.M., Guisto, J.A., Sullivan Jr, J.B. (2002). Environmental Thermal Stress. *Annals Agricultural and Environmental Medicine*, 9(1), 1–15. Retrieved from http://www.aaem.pl/pdf/aaem0201.pdf

Lutz, E. A., Reed, R. J., Turner, D., & Littau, S. R. (2014). Occupational heat strain in a hot underground metal mine. *Journal of Occupational and Environmental Medicine*, 56(4), 388-396. doi:10.1097/JOM.0000000000000107

Mine Safety and Health Administration. (2015). *Coal mining fatalities by state by calendar year.* Retrieved from United States Department of Labor: http://www.msha.gov/stats/charts/coalbystates.pdf

Mine Safety and Health Administration. (n.d.a). *Coal fatalities for 1900 through 2014.* Retrieved from http://www.msha.gov/stats/centurystats/coalstats.asp

Mine Safety and Health Administration. (n.d.b). *Heat Stress in Mining.* Retrieved from http://www.msha.gov/s&hinfo/heatstress/manual/heatmanual.htm

Mine Safety and Health Administration. (n.d.c). *Heat stress...what to do.* Retrieved from http://www.msha.gov/s&hinfo/heatstress/heatstress.htm

Occupational Safety and Health Admisitration. (2014). *Heat Fatalities.* Retrieved from https://www.osha.gov/SLTC/heatillness/map_text.html

Occupational Safety and Health Administration. (n.d.). *Occupational heat exposure.* Retrieved from https://www.osha.gov/SLTC/heatstress/index.html

World Coal Association. (n.d.) *Resources.* Retrieved from https://www.worldcoal.org/resources/frequently-asked-questions/

National Weather Service. (2015). *WetBulb Globe temperature.* Retrieved from http://www.srh.noaa.gov/tsa/?n=wbgt

U.S. Energy Information Administration. (2015a). *Average number of employees by state and mine type, 2013 and 2012.* Retrieved from U.S. Department of Energy Annual Coal Report: http://www.eia.gov/coal/annual/pdf/table18.pdf

U.S. Energy Information Administration. (2015b). *Coal production and number of mines by state and mine type, 2013 and 2012.* Retrieved from U.S. Department of Energy Annual Coal report: http://www.eia.gov/coal/annual/pdf/table1.pdf

Washington State Department of Labor & Industries. (n.d.). *Outdoor heat exposure.* Retrieved from http://www.lni.wa.gov/safety/topics/atoz/heatstress/default.asp

Xiang, J., Bi, P., Pisaniello, D., & Hansen, A. (2014). Health impacts of workplace heat exposure: An epidemiological review. *Industrial Health*, 52, 91-101. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4202759/